



3 1735 033 431 861

1872042

SWANK, James M.

A BIRD'S-EYE VIEW OF THE PRODUCTION AND CHARACTERISTICS OF IRON ORES IN THE UNITED STATES.

DARL
TN403
A3S9

A BIRD'S-EYE VIEW
OF
THE PRODUCTION AND CHARACTERISTICS
OF
IRON ORES IN THE UNITED STATES,

WITH STATISTICS OF IMPORTS OF FOREIGN IRON ORES
IN RECENT YEARS.

By JAMES M. SWANK,
VICE-PRESIDENT OF THE AMERICAN IRON AND STEEL ASSOCIATION.

PHILADELPHIA :
THE AMERICAN IRON AND STEEL ASSOCIATION,
No. 261 SOUTH FOURTH STREET.
1885.

CONTENTS.

	PAGE
OUR IMPORTS OF IRON ORE,	3
DESTINATION OF FOREIGN ORE IMPORTED,	3, 4
COUNTRIES FROM WHICH FOREIGN ORE IS OBTAINED,	4
REASONS WHY FOREIGN ORE IS IMPORTED,	5
PORTS AT WHICH FOREIGN ORE IS ENTERED,	6
THE JURAGUA IRON COMPANY LIMITED,	6
A CANADIAN IRON ORE ENTERPRISE,	6
IMPORTS OF IRON ORE BY EUROPEAN IRON-MAKING COUNTRIES, . . .	7
PRODUCTION OF IRON ORE IN THE UNITED STATES IN 1883 AND 1884, .	7, 8
LEADING IRON ORE DISTRICTS IN THE UNITED STATES,	9
PRODUCTION OF SPIEGELEISEN IN THE UNITED STATES,	10
NEW AND OLD IRON ORE FIELDS IN THE UNITED STATES,	10
THE MARQUETTE DISTRICT,	11
THE MENOMINEE DISTRICT,	12
STATISTICS OF THE MARQUETTE AND MENOMINEE DISTRICTS,	13
THE VERMILLION DISTRICT,	13, 14
THE GOGEBIC DISTRICT,	15, 16
THE IRON ORES OF MISSOURI,	16, 17
THE CORNWALL MINES IN PENNSYLVANIA,	18
THE SALISBURY DISTRICT,	18, 19
THE IRON ORES OF NEW YORK,	19
THE CHAMPLAIN DISTRICT,	19, 20
THE CHATEAUGAY ORE AND IRON COMPANY,	20, 21
THE STERLING AND TILLY FOSTER MINES,	21, 22
THE HUDSON RIVER ORE AND IRON COMPANY,	22
THE IRON ORES OF NEW JERSEY,	22, 23
THE IRON ORES OF OHIO AND PENNSYLVANIA,	24
THE IRON ORES OF INDIANA, ILLINOIS, DELAWARE, AND VIRGINIA, .	25
THE IRON ORES OF WEST VIRGINIA AND NORTH CAROLINA,	26
THE IRON ORES OF KENTUCKY, TENNESSEE, ALABAMA, AND GEORGIA, .	27-29
THE IRON ORES WEST OF THE MISSISSIPPI,	29
SUMMARY,	29-31

THE PRODUCTION AND CHARACTERISTICS OF IRON ORES IN THE UNITED STATES.

THE following paper was contributed to the special report on the Mineral Resources of the United States, by Albert Williams, Jr., Chief of the Division of Mining Statistics and Technology of the United States Geological Survey, Department of the Interior, published in 1885.

IN the preparation of the following essay an attempt has been made to bring together in popular form the leading facts connected with our iron-ore resources and our domestic and foreign iron-ore supplies. No other purpose has been entertained. The facts presented will afford a bird's-eye view of one of the great industries of our country, and of its relation to our extensive iron and steel industries and to the many other industries that are dependent upon them.

Our Imports of Iron Ore.—Previous to 1879 the quantity of iron ore imported into the United States was not recorded, but it did not amount to 100,000 tons in any one year. The quantity of iron ore imported from 1879 to 1884, both years included, was as follows, in tons of 2,240 pounds. The foreign value of the importations in these years is also given.

YEARS.	Gross tons.	Values.
1879.....	284,141	\$681,467
1880.....	493,408	1,436,809
1881.....	782,887	2,222,652
1882.....	589,655	1,640,564
1883.....	490,875	1,207,991
1884.....	487,820	1,133,678

The American Iron and Steel Association has ascertained the destination of 439,183 gross tons of the 487,820 tons of iron ore that were imported in 1884. This information we present in the following table.

STATES AND DISTRICTS.	Gross tons.
New York.....	9,562
New Jersey.....	1,918
Lehigh Valley, Pennsylvania.....	147,891
Schuylkill Valley, Pennsylvania.....	54,211
Upper Susquehanna Valley, Pennsylvania.....	3,076
Lower Susquehanna Valley, Pennsylvania.....	158,361
Allegheny County, Pennsylvania.....	20,288
Conemaugh Valley and Youghiogheny Valley, Pennsylvania.....	40,169
Charcoal Furnaces, Pennsylvania.....	1,492
Maryland.....	600
Ohio.....	1,615
Total.....	439,183

These figures leave 48,637 tons unaccounted for, which were chiefly used in New York, New Jersey, Ohio, and Washington Territory. The figures presented in the table for Pennsylvania and Maryland we believe to be complete, or very nearly so. Of the 439,183 tons accounted for, 81,758 tons were used in the manufacture of pig iron for general purposes, while the remainder was used in the manufacture of Bessemer pig iron and spiegeleisen.

Our imports of iron ore are derived from many countries, but principally from Spain. The following table of imports of iron ore into the United States in the fiscal year which ended June 30, 1884, shows the sources of foreign supply for that year. Statistics for the calendar year 1884 are not obtainable.

COUNTRIES.	Gross tons.	Values.
Spain.....	374,943	\$829,423
Italy.....	57,664	154,857
French Possessions in Africa.....	56,448	109,920
Turkey in Asia.....	4,875	76,601
Dominion of Canada.....	29,125	71,900
England.....	7,555	23,873
Greece.....	12,530	18,615
France.....	4,566	18,410
Portugal.....	6,299	13,942
Mexico.....	1	5
Total.....	553,806	\$1,317,546

The impulse that was given to the importation of iron ore in 1879, 1880, and 1881 was due partly to the high pri-

ces asked for Lake Superior ores, partly to a scarcity of iron ores on the Atlantic Coast that were suitable for the manufacture of Bessemer pig iron, and partly to the revival in the American iron industry in these years which created an extraordinary demand for iron ores for general as well as for special purposes. The first two of these influences have now largely disappeared, and the last one has entirely disappeared. Lake Superior prices have fallen, owing partly to the opening of new mines in that district, and new sources of supply of Bessemer ores have been developed in the East. But in the meantime American capitalists have made extensive investments in Cuban and Canadian iron-ore mines, the product of which is now being brought to this country for the manufacture of Bessemer pig iron, while increasing use of Spanish and Elba iron ores is being made by Eastern furnace owners in the manufacture of pig iron for the general market and for sale to our steel manufacturers.

Much the larger part of the iron ore that was imported in 1882, 1883, and 1884 came from Bilbao and from Mediterranean ports for use in the manufacture of Bessemer and other pig iron chiefly on or near the Atlantic coast, the inducements to import it being its richness, purity, and cheapness. The causes which influenced importations in 1879, 1880, and 1881 taught our people the value of foreign ores, and unless prevented by a high duty such foreign ores as have been used on the Atlantic coast will continue to be imported. The duty on iron ore was changed by the tariff which went into effect July 1, 1883, from 20 per cent. *ad valorem* to 75 cents per ton of 2,240 pounds. That foreign ore can be brought to this country at low prices is due in part, of course, to the very great cheapness of the labor that is employed in mining it, but largely also to the cheapness of ocean freights. The vessels which carry the ore are usually "ocean tramps," which carry grain, petroleum, lumber, and occasionally cotton to Europe, and the owners of which are glad to bring back ore at low rates rather than come in ballast. These vessels are all owned abroad.

The following table shows the quantities and values of iron ore imported into the various customs districts of the United States in the four calendar years 1881, 1882, 1883, and 1884. For this and the preceding table we are indebted to

the courtesy of the Hon. Joseph Nimmo, Jr., Chief of the Bureau of Statistics of the Treasury Department.

DISTRICTS.	1881.		1882.		1883.		1884.	
	Gross tons.	Values.	Gross tons.	Values.	Gross tons.	Values.	Gross tons.	Values.
Baltimore.....	375,798	\$1,005,496	243,182	\$654,629	236,998	\$612,626	184,521	\$357,136
Beaufort, S. C.....					1,473	4,243	1,749	5,005
Boston.....	716	2,867	1,664	3,322	2,470	5,277	2,865	7,765
Buffalo Creek.....	2,492	7,320	273	755				
Champlain.....			2	7	5	28		
Cuyahoga.....	10,500	37,675	9,420	33,181	6,525	17,810	30,964	121,154
Detroit.....	617	1,646	48	98			10	27
Genesee.....	8,716	25,961	6,851	21,651	784	1,740	758	1,897
Huron.....	264	770	264	677	14	4	10	150
New York.....	196,419	641,344	145,909	421,776	36,800	94,236	29,401	82,995
Oswegatchie.....	3,418	10,650	905	2,783	942	2,866		
Oswego.....	13,612	44,026	37,635	120,008	17,862	40,744	11,179	27,856
Perth Amboy.....	13,671	48,323	31,558	101,859	10,082	29,189	50,836	124,257
Philadelphia.....	155,564	394,952	111,944	279,818	170,420	386,386	169,507	388,900
Puget Sound.....	1,100	1,622			3,521	7,084	2,012	4,024
Sandusky.....							2,177	5,387
Vermont.....					2,979	5,758	1,831	7,125
Total.....	782,887	\$2,222,652	589,655	\$1,640,561	490,875	\$1,207,991	487,820	\$1,133,678

The Juragua Iron Company Limited, an American company, has opened extensive mines of iron ore on the south-eastern coast of Cuba, which it purchased early in 1883 and from which shipments to this country commenced in August, 1884. These shipments have since aggregated many thousand tons, and they promise to become in a short time a leading feature of our iron-ore imports. Whether they will result in reducing the supply heretofore received from Spain is yet a matter of conjecture. The quantity of iron ore shipped in 1884 amounted to about 20,000 tons; the shipments in 1885 will probably reach 100,000 tons. The ores from these mines are used for Bessemer purposes. They are rich in iron and very low in phosphorus. The Juragua Iron Company Limited is composed of the Bethlehem Iron Company, the Pennsylvania Steel Company, and Mr. Alfred Earnshaw.

Near Trenton, in the province of Ontario, in the Dominion of Canada, a company of American and Canadian capitalists, which was organized in 1883, has made extensive arrangements, involving a large expenditure of money, for mining iron ore from several mines which have been developed and

from others which have been located. The ores of these mines are said to be well adapted to the manufacture of Bessemer steel. The shipping port is at Weller's Bay, on Lake Ontario, four miles south of Trenton. The shipments to the United States during 1884 amounted to about 40,000 tons. An increase in the shipments for 1885 is expected. The principal promoters of the enterprise are Mr. S. J. Ritchie, of Tallmadge, Ohio; Hon. S. Burke, Hon. Henry B. Payne, and Mr. William Chisholm, of Cleveland, Ohio; the Messrs. McMullen, of Trenton and Picton, Ontario, and the Messrs. Coe, of Madoc, Ontario.

The following table shows the number of tons of iron ore imported during the last six years into each of the leading iron-manufacturing countries of the world.

YEARS.	Great Britain.	France.	Germany.	Belgium.	United States.
1879	1,083,692	941,812	380,000	614,534	284,141
1880	2,634,401	1,168,215	607,007	921,784	493,408
1881	2,449,277	1,287,870	615,490	1,169,206	782,887
1882	3,282,496	1,425,870	785,360	1,206,717	589,655
1883	3,178,310	1,601,217	800,373	1,612,469	490,875
1884	2,728,672	1,412,710	980,442	1,487,748	487,820

It will be seen from this table that the United States is the smallest importer of iron ore of all the countries mentioned. If we consider its prominent place among these countries, being second in the production of iron and steel, it is very much the smallest importer.

Production of Iron Ore in the United States in 1883 and 1884.—Full statistics of the production of iron ore in the United States are not obtained, and can not be obtained, except in census years. The annual production of iron ore in the whole country may, however, be very accurately estimated. The average quantity of iron ore that is used in producing a ton of pig iron in the United States, in addition to the mill cinder that is used in some furnaces, is shown by the census of 1880 to be about 1.9 tons, while the production of pig iron is definitely ascertained from year to year by the American Iron and Steel Association, so that the quantity of iron ore produced in any year and used at our blast furnaces is approximately ascertained by multiplying the year's production

of pig iron by 1.9 and deducting from the product the quantity of iron ore imported. By this method we obtain the following results for 1884. The pig iron produced, 4,097,868 gross tons, multiplied by 1.9 gives 7,785,949 tons, from which, if we deduct 487,820 tons of iron ore imported, we have 7,298,129 tons as the home production of the year that was used at our blast furnaces. This country also annually produces in forges directly from the ore about 40,000 gross tons of blooms and billets, representing about 120,000 tons of native ore. The largest and best of these forges are located in the Champlain district of New York, while others are found in Tennessee, North Carolina, Virginia, and Missouri. We also use some iron ore as fettling in the puddling furnaces of our rolling mills, and the quantity so used in 1884 we estimate, upon the basis of the census figures of 1880, to have amounted to about 300,000 tons, which, added to the domestic ore used in our blast furnaces and forges, gives us 7,718,129 gross tons as the probable production and consumption of domestic iron ore in 1884. This calculation takes no account of ore produced and not consumed.

That the figures above given of the production and consumption of iron ore in the United States in 1884 are correct is proved by statistics obtained by the American Iron and Steel Association. In response to a circular letter addressed to all the manufacturers of iron and steel in the country, and which was very generally answered, detailed information was furnished which indicates that the aggregate consumption of domestic iron ore in 1884 amounted to 7,639,581 gross tons. This result is so close to the result reached by the method adopted in the preparation of this paper that it may safely be assumed that the quantity given by that method (7,718,129 tons) is correct and should stand.

As incidental to the present inquiry it may be stated that, if we eliminate the mill cinder from the census statistics of 1880, and the probable amount of pig iron that was produced with it, it will appear that an average of 2.03 tons of iron ore was in that year required to produce a ton of pig iron. This is below the average in the leading iron-producing countries of Europe. Great Britain averages 2.4; Germany, 2.6; France, 2.6; and Belgium, 2.7.

The following statistics showing the production of domestic iron ore in 1883 and 1884 in certain leading districts have been obtained from reliable sources of information. As will be observed, the figures for 1884 embrace more than half the total estimated consumption of that year.

DISTRICTS.	1883.	1884.
	<i>Gross tons.</i>	<i>Gross tons.</i>
Lake Superior Mines of Michigan and Wisconsin.....	2,352,288	2,455,924
Vermillion Lake Mines of Minnesota.....	Not opened.	62,124
Missouri.....	295,430	233,225
Cornwall, Pennsylvania.....	363,143	412,320
Chateaugay Mines, near Lake Champlain.....	194,704	214,394
Other Lake Champlain Mines, including the Port Henry and Crown Point Mines.....	305,300	290,500
New Jersey.....	521,416	393,710
Salisbury District, Connecticut.....	35,000	25,000
Hudson River Ore and Iron Company, New York.....	20,000	90,000
Total.....	4,087,281	4,177,197

In 1882 the Lake Superior region and the State of New Jersey reached respectively the largest production of iron ore in their history. In the former 2,947,392 gross tons were produced, and in the latter the production was 932,762 tons.

The remainder of our domestic supply of iron ore in the two years mentioned, as well as in previous years, was obtained from mines located in all the States and Territories that produce pig iron, and located, too, in nearly every case in close proximity to the blast furnaces. There are very few States and Territories in the Union in which iron ore has not been discovered. The large number of "local mines" in so many States and Territories indicates not only the wide distribution of iron ore in our country, but also the existence of a disposition among the people of all sections to develop the various deposits as promptly as the wants of the country require. The iron-making instincts of our people are shown fully as much in their search for native iron ores and in the means they have used to develop them as in their readiness to adopt the best modern methods of manufacture. A less energetic people, for instance, would have been appalled by the difficulties which confronted the first shippers of iron ore from the Lake Superior region, and there are not to be found anywhere in the world to-day better or more expensive machinery and ap-

pliances for the mining of iron ore than are to be found in that district.

The latest illustration we have had of the enterprise of our people in seeking at home for new sources of supply of iron ore of a quality or character that had not previously been discovered, or discovered in insufficient quantities, is seen in the search of our Bessemer steel manufacturers for manganiferous iron ores in Michigan, Virginia, Georgia, Alabama, and Arkansas—a search which has resulted in a considerable increase during the past year in our production of spiegeleisen and ferro-manganese. The production amounted to 33,893 net tons, of which New Jersey produced 7,058 tons, Pennsylvania 26,509 tons, and Colorado 326 tons. The following table shows the production of these articles in the United States since 1875. In each year foreign as well as domestic ore was used, but in 1884 there was a marked diminution in the use of foreign ore.

Years.	Net tons.	Years.	Net tons.
1875.....	7,832	1880.....	19,603
1876.....	6,616	1881.....	21,086
1877.....	8,845	1882.....	21,963
1878.....	10,674	1883.....	24,574
1879.....	13,931	1884.....	33,893

New and Old Iron Ore Fields in the United States.—Of the important deposits of iron ore that have been developed in this country and are still worked the Salisbury district in Western Connecticut was developed as early as 1731; the Schuylkill Valley mines in Pennsylvania were developed in 1716, and the Cornwall “ore hills” in the same State about 1735; the magnetic ore mines in Northern New Jersey were opened about 1710; the Sterling mines in Orange county, New York, in 1750, and the Champlain district in the same State about 1800; the Tennessee mines, the mines in Bath county, Kentucky, the Cranberry mines in North Carolina, and the Juniata Valley mines in Pennsylvania near the close of the last century; the Hanging Rock region of Kentucky during the second decade of the present century, and the same region in Ohio during the third decade. The Iron Mountain and Pilot Knob region in Missouri was developed about 1845. The existence of iron ore on the southern shore of Lake Superior, the most celebrated and most productive iron-ore region in this country, was not even discovered until

about 1830, and no attempt was made to develop it until 1845, just forty years ago. It is a noticeable fact, however, that, notwithstanding our early enterprise as iron manufacturers, some of the richest deposits of iron ore in this country were not developed, and in some instances were not discovered, until in very recent years. No attempt was made to develop some of these deposits until after the boom of 1879 and 1880, while the development of others was greatly stimulated by that event.

A notice of the location and characteristics of some of the older iron-ore fields above referred to and of all of the most recently developed deposits is demanded by the increasing public interest in the general question. Such illustrative chemical analyses as will be presented have in every instance been obtained from reliable sources.

1. The celebrated Marquette district, in Michigan, the most productive of all the iron-ore districts in the country, is mainly embraced in Marquette county, a small part of it extending northwest into Baraga county. Its principal ports of shipment for the ores that are not consumed in local furnaces are Marquette and Escanaba, the former on Lake Superior and the latter on Lake Michigan. Small quantities of ore are annually shipped from this district at L'Anse, on Lake Superior. There are at present several charcoal furnaces in the district.

The great extent and great richness and purity of the hematite and magnetic iron ores of the Marquette district are too well known to require extended reference. The district is by far the most important iron-ore field in the United States.

We subjoin a collection of fourteen analyses of the ores of the Republic mine, one of the most noted mines of the Marquette district, which we take from Mr. A. P. Swineford's *Mineral Resources of Lake Superior*, printed in 1876. This mine is operated by the Republic Iron Company.

[illegible]

The iron ore of the Champion mine shows 67 per cent. of iron, 3 per cent. of silica, and .03 per cent. of phosphorus. Several analyses of West Republic ore that are before us show iron ranging from 66.483 to 68.583 per cent., and phosphorus ranging from .039 to .054 per cent. Two analyses of the specular ore of the Lake Superior mine give the following results.

Metallic iron.....	64.831	65.680
Silica.....	3.600	3.700
Alumina.....	2.030	2.370
Lime.....	.550	.700
Magnesia.....	.600	.350
Phosphorus.....	.067	.095

2. The Menominee Range district is mainly situated in Menominee county, Michigan, the western part of it extending into Florence county, Wisconsin. This district ranks second in productiveness to the Marquette district. Both districts lie on the southern shore of Lake Superior.

The Menominee district owes its development mainly to the enterprise of the Menominee Mining Company, of Milwaukee. About 1876 this company obtained control of a large extent of country owned by the Lake Superior Ship Canal, Railway, and Iron Company, and by other parties, and at once commenced active operations. In 1877 10,405 tons were shipped, and thereafter shipments rapidly increased, both from the mines of this company and from mines opened by other capitalists. The Menominee Mining Company is still the largest shipper in the district, and the next largest is the Penn Iron Mining Company, a corporation which was organized in 1882 and which represents a large amount of Pennsylvania capital. The ore from this district is all shipped at Escanaba to ports below, except a very small quantity which is used at two local charcoal furnaces.

The ores of the Menominee district are generally red hematites, and partake of the same general characteristics as similar ores of the Marquette district, except that they are as a rule softer. They are found in large deposits. We subjoin analyses of the ores of some of the mines operated by the Penn Mining Company. These analyses were made by the Cambria Iron Company from ores used in its blast furnaces.

	Vulcan.	Cyclops.	Norway.	Quinnesec.
Iron	63,930	60,470	58,940	67.05
Silica	6,860	3,380	12,270	4.80
Phosphorus.....	.013	.009	.016	.01

3. The statistics of the Marquette and Menominee iron-ore districts have usually been given together, but the districts are not contiguous. In a list of eighty-two mines in the two districts, which we find credited in the Marquette *Mining Journal* with having produced iron ore in one or all of the last three years, fourteen are located in the Menominee district. The production of iron ore in 1884 in these two districts and by the isolated Colby mine, in Ontonagon county, also in Upper Michigan, was 2,455,924 gross tons, of which the Menominee district produced 698,047 tons. In 1882, however, the two districts alone produced the exceptionally large quantity of 2,947,392 tons, and in that year the proportion of the Menominee district was 1,032,611 tons. The most productive mine in the whole Lake Superior region in 1883 and 1884 was the Chapin mine, in the Menominee district, which produced 265,830 tons in 1883 and 290,972 tons in 1884. The Lake Superior mine, in the Marquette district, has, however, produced a still larger annual product, its output in 1882 being 296,509 tons. This latter mine has been the most productive of all the mines in the Lake Superior region, the Cleveland, Jackson, and Republic mines, in the same district, coming next, in the order mentioned.

Since 1856 the total production of iron ore on the southern shore of Lake Superior has amounted to 24,809,391 gross tons. Most of the capital that has been invested in the development of the iron ores of this region has been supplied by New England, New York, Pennsylvania, and Ohio.

4. The Vermillion Lake iron district, in St. Louis county, Minnesota, on the northern shore of Lake Superior, embraces several extensive mines that are opened or exposed, the most of them containing hard hematite ores of the same general characteristics as those found on the southern shore of the lake. The first shipment of iron ore from this district took place on the 31st of July, 1884, over the Duluth and Iron

Range Railroad, which connects Two Harbors, on Lake Superior, twenty-five miles northeast of Duluth, with the town of Tower, at the mines, the distance between the two places being seventy-two miles. This road, which is under the control of the Minnesota Iron Company, the owner of all the mines, is to be continued from Two Harbors to Duluth, where it will connect with the railroad system of the United States. At Two Harbors are extensive piers at which vessels will receive the ore, which it is expected will find its principal markets at ports on the lower lakes. The shipments in 1884, all to these ports, amounted to 62,124 gross tons. Shipments will be largely increased in 1885. Of the vast extent and uniformly good quality of the iron ores of this district there is no room for doubt, and the facilities for shipment are favorable. The policy of the company will be to ship only the best ores. All of the Vermillion Lake ores are sufficiently low in phosphorus for Bessemer purposes, but they contain little or no manganese.

The existence of iron ore in this district was discovered by explorers about twenty years ago, but it was not until 1874 that any steps were taken to ascertain their extent or value, and not until 1883 that the building of the railroad was commenced. A few of the mines were opened in 1881 and 1882. The development of this district is in the hands of experienced capitalists, at the head of whom is Mr. Charlemagne Tower, of Philadelphia.

The following analyses, made by Messrs. Carnegie Brothers & Company Limited, of Pittsburgh, present a fair average of a large number which have been made of average samples from the Vermillion mines. The analyses here given are of ores from the mines which supplied the shipments in 1884.

	Breitung Mine.	Stone Mine.	Lee Mine.
Iron.....	69.700	69.160	67.180
Manganese.....		trace	
Phosphorus.....	.047	.053	.050
Sulphur.....	.007	.008	.025
Silica.....	.700	.700	2.150
Alumina.....		.400	1.230
Lime.....	.350		.450
Magnesia.....	trace	trace	.320

It is a fact of much interest that Minnesota, one of our prairie States, should promise to become a large producer of iron ore.

5. In the vicinity of Gogebic Lake, in Ontonagon county, Michigan, on the southern shore of Lake Superior, and west of the Marquette and Menominee iron-ore districts, are extensive deposits of iron ore of the same general characteristics as the ores found in all the other Lake Superior districts. The existence of marketable iron ore in this district was discovered in 1880, but owing to the absence of railroad transportation no attempt was made until quite recently to develop any of the deposits, which will not be worked together, being controlled by various projectors and operators, principally under leases from the Lake Superior Ship Canal, Railway, and Iron Company. About twenty openings have been made, but down to the close of 1884 shipments of ore had been made from only the Colby mine, lying about six miles east of the Montreal river. It is claimed that the existence of extensive forests of hard wood in close proximity to the iron-ore deposits and to calcareous marl as a fluxing material justifies the erection of blast furnaces in the district. Analyses of numerous samples of marl found in the district show the deposits to consist of nearly pure carbonate of lime with but a trace of phosphorus.

The Milwaukee, Lake Shore, and Western Railway was completed to the Gogebic district in 1884, and during 1885 it is expected that it will be completed to Ashland, Wisconsin, on Lake Superior, where there is an excellent harbor and where expensive piers are being built, and from which it is expected that considerable shipments of iron ore to lower lake ports will be made before this year closes. It was over this road that the ore from the Colby mine was shipped by way of Milwaukee in 1884. The quantity shipped amounted to 1,022 gross tons. It was received by Carnegie Brothers & Company Limited, of Pittsburgh, for use in their blast furnaces, and gave complete satisfaction. It contained a large percentage of manganese. From the Colby mine to Ashland the distance by railroad will be less than fifty miles, and from any of the mines in the vicinity of Gogebic Lake to Ashland the distance will probably not exceed seventy-five miles.

In Ashland county, Wisconsin, just west of the Montreal river, which forms the boundary between Michigan and Wisconsin, are several promising iron-ore deposits which await development.

Analyses of the iron ores of the Gogebic district show that they are rich in metallic iron, very low in phosphorus, variable in silica, and free from sulphur. They are as a rule adapted to the manufacture of Bessemer pig iron. In a few mines manganese is also found in sufficient quantity in combination with iron to produce spiegeleisen. We subjoin a few analyses of ore from the Colby mine.

	1.	2.	3.	4.	5.
Iron and manganese.....	60.040	62.340	62.760	66.020	61.270
Metallic iron.....	48.630	55.490	57.140	65.100	52.700
Phosphorus.....	.083	.070	.071	.042	.075
Silica.....	6.080	2.680	3.690	8.840	1.820
Manganese.....	11.410	6.850	5.620	.920	8.570

Most of the analyses of the iron ores of this district that have been made show metallic iron ranging from 50 to 66 per cent.

6. There are four distinct iron-ore fields in Missouri, known as the Iron Mountain, the Southeastern, the Southwest, and the Western districts. "The Iron Mountain region," to quote the words of Mr. W. B. Potter, "although much the smallest in area, is by far the most important, since it has produced, and still is capable of producing, more ore than all the other regions combined." This district is located in Iron and St. François counties, from eighty to ninety miles south of St. Louis. The principal deposits of the district are known as Iron Mountain and Pilot Knob. The former has been worked since 1845 and the latter since 1847. They have frequently been described. Iron Mountain alone has produced about 3,000,000 tons of ore; Pilot Knob has produced about 1,000,000 tons. In 1872 there were mined and shipped from Iron Mountain alone 269,480 tons. A large part of the production of Iron Mountain and Pilot Knob has been taken to Pittsburgh and other places on the Ohio river, but in recent years shipments have been mainly to nearer localities. Below are two analyses of Iron Mountain ore, which we take from a paper

prepared by Mr. W. B. Potter in 1884, and published in the *Journal of the United States Association of Charcoal Ironworkers*.

	Surface ore.	Bluff ore.
Peroxide of iron.....	95.040	90.610
Protoxide of iron.....	2.570	2.800
Silica.....	1.570	3.750
Alumina.....	.790	2.160
Lime.....	.170	.480
Magnesia.....	.140	.320
Manganese.....	none	trace
Sulphur.....	.005	trace
Phosphoric acid.....	.071	.075
	100.356	100.195
Metallic iron.....	68.530	65.610
Phosphorus.....	.031	.033

The following analyses show the chemical composition of the iron ores of Pilot Knob.

Peroxide of iron.....	84.330	90.870
Protoxide of iron.....	0.150	1.670
Silica.....	13.270	5.180
Alumina.....	2.190	.890
Lime.....	.210	1.760
Magnesia.....	.140	.130
Manganese.....	none	none
Sulphur.....	trace	.078
Phosphoric acid.....	.035	.069
	100.325	100.647
Metallic iron.....	59.150	64.9100
Phosphorus.....	.015	.0031

A statement which we have received from the Iron Mountain Company gives the average analysis of a series of samples of No. 1 ore from Iron Mountain as follows :

Metallic iron.....	65.5000
Silica.....	5.7500
Sulphur.....	.0160
Phosphorus.....	.0403

In Crawford and Dent counties, Missouri, in the Southwest section, just west of the Iron Mountain district, are numerous mines of rich ore that are operated by the Missouri Iron Company and by others. We have received from this company several analyses of the ores of this section, which show metal-

lie iron ranging in every case above 60 per cent., with a very low percentage of phosphorus, little or no sulphur, and variable silica. We have room for only one of these analyses, relating to the surface ore of Simmons Mountain.

Peroxide of iron.....	98.140	Phosphoric acid.....	.038
Silicic acid.....	1.410		
Alumina.....	.060		99.998
Lime.....	.240	Metallic iron.....	68.690
Magnesia.....	.110	Phosphorus.....	.016

7. The immense Cornwall iron-ore deposit in Lebanon county, Pennsylvania, appears to be no nearer exhaustion to-day than when it was first opened, a hundred and fifty years ago. We give below detailed analyses of six samples of the ore of the Cornwall mines, "selected," as we are informed, "to give a general average of the quality of the ore." The mines supply a large number of local and neighboring furnaces. Pig iron made from this ore has been largely used as a mixture with other pig iron in the manufacture of Bessemer steel.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Magnetic oxide of iron.....	78.278	62.198	67.282	68.965	53.075	41.131
Sesquioxide of iron.....			trace	22.794		52.298
Oxide of copper.....	1.840	1.480	trace	0.250	1.300	0.030
Oxide of cobalt.....	0.200	0.095	0.153	0.067	0.076	0.105
Oxide of manganese.....	trace	trace	trace	trace	trace	trace
Magnesia.....	1.286	2.695	1.867	1.228	3.193	1.369
Lime.....	1.060	1.110	1.210	1.403	1.510	1.111
Sulphuric acid.....	0.039	0.204	0.105	0.013	0.187	
Phosphoric acid.....	0.072	0.010	0.006	0.002	0.003	0.006
Quartz and silica.....	11.082	28.000	18.240	2.200	37.860	3.840
Copper pyrites.....	0.352	1.818	0.232	0.084	0.604	
Iron pyrites.....	5.222	1.792	8.299		1.479	
Water, etc.....	0.629	0.598	2.522	2.943	0.603	2.107
	100.000	100.000	100.000	100.000	100.000	100.000
Metallic iron.....	59.229	46.422	52.666	65.952	39.380	64.992
Metallic copper.....	1.589	1.814	0.080	0.200	1.246	0.024
Phosphorus.....	0.032	0.004	0.002	0.007	0.001	0.002
Sulphur.....	2.910	1.672	4.549	0.045	1.076	

8. The Salisbury iron region is properly confined to the town, or township, of this name in the northwestern portion of Litchfield county, Connecticut, but it is frequently referred to as embracing also the contiguous counties of Columbia and

Dutchess in New York and Berkshire in Massachusetts, the whole constituting a strip of country from ten to fifteen miles wide, in which may be found about twenty charcoal furnaces. The ores of this celebrated region are brown hematites, some of which are found in beds and others in veins. In the Salisbury region proper there are seven charcoal furnaces, which are supplied with ores from three mines, known as Old Hill, Davis, and Chatfield. Iron has been manufactured in this part of Connecticut since 1734. We subjoin complete analyses of the ores of the three mines mentioned, which still show no signs of exhaustion.

	Davis.	Chatfield.	Old Hill.
Sesquioxide of iron.....	75.720	78.136	73.51
Sesquioxide of manganese.....	1.376	.826	.96
Silica.....	7.580	6.630	10.48
Sulphur.....	.082	.048	.07
Phosphoric acid.....	.032	.501	.57
Lime, magnesia, alumina, water, etc.....	15.210	13.857	14.41
	100.000	99.998	100.00
Metallic iron.....	53.000	54.696	51.45
Metallic manganese.....	.958	.576	.67
Sulphur.....	.082	.048	.07
Phosphorus.....	.014	.219	.25

The pig iron produced from the Salisbury iron ores is in high repute for the manufacture of car-wheels and of rolls for rolling mills, but it is also in demand for all purposes requiring great strength and tenacity. More than a century ago there were many forges in this district which produced bar iron of superior quality. The American navy has been supplied with many guns made from Salisbury iron. Only the ore of the Davis mine appears to be adapted to the manufacture of steel.

9. The State of New York is very rich in iron ore, the principal deposits of which lie along its eastern border, on both banks of the Hudson river and in the neighborhood of Lake Champlain. Much of the ore is magnetic, rich in iron, and low in phosphorus. In Clinton and Essex counties, in the Champlain district, iron has been made directly from the

ore in numerous charcoal forges (more properly bloomaries) since the beginning of the century, and considerable quantities of pig iron have also been made in these and neighboring counties with anthracite coal and with charcoal. The annual production of iron ore in this district ranges from 500,000 to 600,000 tons. The quality of the iron made in this whole region is most excellent, and it enjoys a high reputation for various uses. As a rule the iron ores of this district are not adapted to the manufacture of any kind of steel, but some Bessemer pig iron is made in the district, and some mines produce ores the blooms and billets from which have been used in the manufacture of crucible steel.

We subjoin seven analyses of the ore of one of the oldest iron-ore companies in this section, the Port Henry Iron Ore Company, whose mines are located in Essex county.

	1.	2.	3.	4.	5.	6.	7.
Magnetic oxide of iron.....	88.323	88.772	76.608	81.381	85.559	84.623	92.78
Phosphoric acid.....	1.791	1.513	4.227	4.694	3.297	3.495	.71
Equivalent to—							
Metallic iron.....	63.958	64.287	55.475	58.935	61.957	61.279	67.19
Phosphorus.....	.782	.661	1.846	2.050	1.440	1.528	.31

10. The Chateaugay Ore and Iron Company, whose operations are on a large scale, was organized in 1881, (after the boom of 1879 and 1880,) for the development of the Chateaugay mines, in the vicinity of Chateaugay Lake, in Franklin county, west of Lake Champlain, the port of shipment being Plattsburgh, on the last-named lake, with which the mines are connected by a railroad 35 miles long, owned by the company. The company owns about 75,000 acres of land. Since the commencement of operations in 1881 it has mined 752,101 tons of ore. The output was 102,626 tons in eight months of 1881, 240,377 tons in 1882, 194,704 tons in 1883, and 214,394 tons in 1884. To meet an extraordinary demand a production of 500,000 tons per annum is possible, the mines being fully equipped with powerful machinery and the ore being favorably situated. The mining plant employed by this company is one of the most extensive and complete in the country. In addition to its mining operations the company is a large producer of charcoal blooms, owning a number of forges in the

neighborhood, and it also owns and operates one charcoal furnace at Plattsburgh. Much the larger portion of the ore produced by this company is, however, sold to furnace owners in New York and neighboring States, where it has been used in the manufacture of Bessemer steel and for other purposes. We subjoin an analysis of Chateaugay ore, which we obtain from the company.

Peroxide of iron.....	47.380	Sulphur.....	.084
Protoxide of iron.....	21.320	Silica	20.890
Protoxide of manganese.....	.210		
Alumina.....	4.020		99.791
Lime.....	3.720		
Magnesia.....	2.110	Iron.....	49.750
Phosphoric acid.....	.057	Phosphorus.....	.025

11. In the immediate vicinity of New York City, and near to the Hudson river, are two celebrated iron-ore fields—one known as the mines of the Sterling Iron and Railway Company, which have been worked since 1750, and the other known as the Tilly Foster mine. The Sterling mines embrace about 22,000 acres in Orange and Rockland counties, and the Tilly Foster mine is in Putnam county. The Sterling ores are most used in the manufacture of foundry and mill pig iron, but the ore of some of the mines is a pure Bessemer ore. The reputation of the Sterling ores was made by the Long mine, which was discovered in 1750. The “big mine” is the one that is now most worked. Its ores contain some phosphorus. The company itself operates two anthracite furnaces. We give below analyses of the ores of two of the Sterling mines.

	Cook mine.	Scott mine.
Iron.....	64.24	65.47
Oxygen.....	24.48	24.93
Silica.....	7.45	4.92
Sulphur.....	none	none
Phosphorus.....	.184	.52
Alumina.....	1.13	.71
Lime.....	.72	1.59
Magnesia.....	.29	.56
Oxide of manganese.....	.17	.32
	98.664	99.02

The Tilly Foster ore is largely used by the Lackawanna

Iron and Coal Company in the production of Bessemer pig iron, at Scranton, Pennsylvania, and it has also been used for the same purpose by the Bethlehem Iron Company. We subjoin an analysis of this ore which has been furnished us by the first-mentioned company.

Magnetic oxide of iron.....	67.41	Sulphur.....	.08
Oxide of manganese.....	.30	Carbonic acid.....	2.30
Silica.....	11.75	Phosphoric acid.....	.05
Alumina.....	3.50		
Lime.....	2.15		100.78
Magnesia.....	13.24	Metallic iron.....	48.82

Several other iron-ore deposits of similar character, which are apparently large but imperfectly developed, exist within a few miles of the Tilly Foster mine.

12. A new iron-ore field was developed in 1883 on the east side of the Hudson river, in Columbia county, by the Hudson River Ore and Iron Company, which has expended a large sum of money in prosecuting its enterprise. The ore of this district is described as a carbonate that is not greatly unlike the Cleveland ore in England, but much richer. When roasted it is adapted to the manufacture of Bessemer steel. The quantity of ore mined in 1884 by the company owning this property amounted to 90,000 tons. The deposits are very large. We subjoin two analyses of the ore after it had been roasted, which we take from *The Iron Age*.

	1.	2.
Iron.....	51.160	50.820
Silica.....	9.200	9.030
Sulphur.....	.550	.600
Phosphorus.....	.029	.031

We are furnished by Messrs. Crocker Brothers, of New York, the agents of the Hudson River Ore and Iron Company, with the following more complete analysis of roasted ore.

Peroxide of iron.....	66.991	Silica.....	11.030
Protoxide of iron.....	3.584		
Protosesquioxide of manganese.....	3.966		99.690
Alumina.....	2.637		
Lime.....	3.720	Iron.....	49.682
Magnesia.....	7.125	Phosphorus.....	.038
Phosphoric acid.....	0.087	Sulphur.....	.580
Sulphuric acid.....	1.450	Manganese.....	2.209

13. All of the iron ores of New Jersey that are now mined are in the northern part of the State. They are chiefly magnetic. In the last century and during a considerable part of

the present century bog ore was used in a number of charcoal furnaces in the southern part of the State. Most of the ores that are now mined are only suitable for forge or foundry purposes, but some are well adapted to the manufacture of Bessemer pig iron as they come from the mine, while others contain too much sulphur for this purpose and require to be roasted. These ores are also roasted when used for other purposes. We subjoin two analyses of magnetic ores, obtained in Sussex county, which are very low in sulphur and are used at Franklin furnace in the manufacture of Bessemer pig iron.

	Hill vein.	Furnace vein.
Magnetic oxide of iron.....	69.50	65.40
Oxide of manganese.....	.46	4.13
Silica.....	18.27	1.05
Alumina.....	.27	.18
Lime.....	5.00	9.74
Magnesia.....	2.73	6.44
Sulphur.....	.10	.45
Carbonic acid.....	3.55	11.93
Phosphoric acid.....	.03	.05
Graphite.....		.78
	99.91	100.15
Metallie iron.....	50.32	47.35

A larger general average of New Jersey magnetic ores would show a higher percentage of metallic iron and would be more favorable in other proportions for special purposes. For example, the ore of the Richard mine, in Morris county, owned and operated by the Thomas Iron Company, averages 60 per cent. of metallic iron, and contains some phosphorus but no sulphur.

The present state of the iron-ore industry of New Jersey is described as follows by the State Geologist, Professor George H. Cook, in his annual report for 1884: "The low price of iron ore and the light demand for ore at almost any figure have caused a large shrinkage in the production and closed many of our mines. The large and increasing importations of iron ores from Spain and Africa also operate against our mines, since these rich and pure foreign ores can be put down at the furnaces near the seaboard at lower rates, per unit of metallic

iron, than the New Jersey ores can be profitably mined and shipped to these same points. Besides, the adaptation of the former to the making of Bessemer iron enables them to compete successfully with our own Bessemer ores which are as yet scarcely developed. The discovery of new and productive mines along the Hudson, where ore can be obtained at a minimum of cost, also makes the competition for the Pennsylvania market sharp and telling against some of our mines where the expenses of mining are relatively larger, although our magnetic ores are richer."

14. So many varieties of iron ore are found in Ohio, and they are so widely distributed, that the State at first sight might be called rich in iron ore, and yet it annually makes more iron from Michigan ores than from the ores of its own mines. Pennsylvania, also, although celebrated as our leading iron-producing State, annually makes more iron from ores mined outside its borders than within them. A quarter of a century ago Professor Lesley wrote of Pennsylvania: "The reputation of this State for iron has resulted more from the energetic, persevering German use, for a century of years, of what ores do exist, than from any extraordinary wealth of iron of which she can boast." In Ohio the ores of native origin are generally very lean, and too high in phosphorus to be serviceable in the manufacture of steel. Economy in the one case and necessity in the other combine to create a demand for Michigan ores, which are transported to ports on Lake Erie at comparatively slight cost, meeting the fuel to smelt them at many places in Ohio, even as far south as the Ohio river. Michigan ores are taken in large quantities to the Shenango Valley and to Allegheny, Cambria, and other counties in Western Pennsylvania. Spanish and other foreign ores also find their way to this part of the State, and are still more largely consumed in the eastern part, in both sections meeting the best of mineral fuel. Michigan and foreign ores are used in Pennsylvania because of their fitness as a mixture with native ores and their comparative cheapness, and because also of the leanness of so many of the native ores and of the phosphorus that most of them contain.

We omit analyses of the ores of Ohio and Pennsylvania as unnecessary. It must be added, however, that Ohio is a

large manufacturer of rolled iron and of the best qualities of foundry iron, produced from its Hanging Rock, blackband, and other native ores, and that the bar, plate, and sheet iron of Pennsylvania and its foundry iron, made exclusively from native ores, are unexcelled anywhere. In both States charcoal is still used as fuel in many furnaces.

15. Indiana and Illinois produce so little iron ore that details may properly be omitted. The same observation may be made of all the New England States except Connecticut, which has already been noticed. Illinois is, however, one of the most prominent iron and steel producing States in the Union, but the ores it uses are mostly drawn from Lake Superior and Missouri, and the fuel for its blast furnaces is obtained mainly from the Connellsville region of Pennsylvania.

16. Delaware does not now manufacture pig iron, although it contains some small deposits of very good ores for general purposes. Maryland is not a large manufacturer of pig iron, but the pig iron that it makes from its own ores is noted for its great strength and also for its adaptability to the manufacture of car-wheels. Some foreign ores are imported into this State for use as a mixture with native ores. Very little Bessemer pig iron has been made in Maryland.

17. Iron ores are found in most parts of Virginia, and they are usually of good quality, although very few are perfectly adapted to the manufacture of Bessemer steel, and these have thus far been found mainly in small pockets. It is possible that large bodies of ore may yet be developed along the lines of the Norfolk and Western and the Shenandoah Valley railroads, and elsewhere, which will be suitable for the manufacture of steel. In Southwestern Virginia pig iron of a very superior quality for the manufacture of car-wheels has long been made in charcoal furnaces. In other parts of Virginia pig iron of excellent quality is made in a few charcoal furnaces and in several new and large coke furnaces, and this iron is finding a market for general purposes as far north as New England.

Near Crimora Station, in Augusta county, Virginia, on the Shenandoah Valley Railroad, there exists a large deposit of manganese ore, which has been worked for several years and which has contributed during the past year a considerable

quantity of ore for the manufacture of spiegeleisen and ferromanganese in Pennsylvania. An analysis of this ore gives 57.291 per cent. of metallic manganese, .373 of metallic iron, and .075 of phosphorus. There are other promising deposits of manganese ore in this State.

In West Virginia a great variety of iron ores is also found, which are smelted with both coke and charcoal, but few if any of these have been used in the manufacture of steel. The Bessemer steel that is now manufactured at Wheeling is made from pig iron smelted from Lake Superior and Missouri ores. The State is more noted for its coal deposits and for the large quantities of nails it manufactures than for its iron ores.

18. An extensive deposit of magnetic iron ore is found on the western slope of Iron Mountain, in Mitchell county, North Carolina, about three miles from the Tennessee line, which is known as the Cranberry "ore bank." This deposit has been worked in a small way for a hundred years, the ore being converted into bar iron in neighboring bloomaries, but recently the Cranberry Iron Company has made preparations to ship the ore to other sections of the country, and it has also built a small charcoal furnace at the mines. The distance from the mines to places of consumption is, however, so great that up to the present time but little ore has been shipped, although its superior adaptability to the manufacture of steel is everywhere acknowledged. It is practically free from sulphur and phosphorus. We subjoin five analyses of Cranberry ore, which we obtain from Mr. P. M. Hale's work on *The Coal and Iron Counties of North Carolina*.

	1.	2.	3.	4.	5.
Magnetic oxide of iron.....	94.37	91.45	85.59	80.77	91.89
Oxide of manganese.....	.26	.06	.24	1.42	.32
Alumina.....	.42	.77	.11	.52	1.03
Lime.....	.43	1.01	.72	.....	1.06
Magnesia.....	.36	.53	.33	.....	.23
Water.....	.....	.44	1.53	8.21	1.15
Silica, pyroxene, etc.....	4.16	5.74	11.48	9.08	4.02
Sulphur.....	.....	.....	.....	.....	.25
Phosphoric acid.....	.....	.....	.....	.....	trace
	100.00	100.00	100.00	100.00	99.95
Metallic iron.....	68.84	66.22	61.98	58.49	66.53

North Carolina has many other deposits of magnetic and hematite ores, which have been fitfully worked in a small way for more than a century, but none of these deposits, not even the Cranberry "ore bank," will compare in extent with the immense deposits of Lake Superior, the Iron Mountain and Pilot Knob in Missouri, and the Cornwall "ore hills" in Pennsylvania. The coal deposits of North Carolina are as yet practically undeveloped.

19. The iron ores of Kentucky, Tennessee, Alabama, and Georgia embrace most known varieties, and they are certainly found in very large quantities and are widely distributed. They have been worked for many years, some of them for a hundred years, and much of the iron made from them has enjoyed a very high reputation for strength and toughness. Until in recent years charcoal was exclusively used as fuel, but now coke is largely used, chiefly in new and modern furnaces. Chattanooga and Birmingham are now as well known iron centres as Pittsburgh, Youngstown, Johnstown, or other places in the North. Southern pig iron is shipped to Philadelphia, New York City, and to New England markets and is sold at a profit. The impetus that has recently been given to the iron industry of this section is largely due to investments of Northern capital. The four Southern States mentioned do not as a group produce any appreciable quantity of steel, and for the reason that very few ores suitable for the manufacture of steel have been discovered. Even in the vicinity of Birmingham, where there are a dozen furnaces, no attempt has yet been made to manufacture Bessemer pig iron, because suitable ores are not within reach. Some ores, it is true, are sufficiently low in phosphorus, but they are practically unfitted for the manufacture of steel because of the very great irregularity in the occurrence of this obnoxious element. Ore has been taken from some hematite veins in Alabama that was almost free from phosphorus, but twenty yards distant in the same vein one-half of one per cent. of phosphorus has been found. In Georgia and Alabama several small mines of manganese iron ore suitable for the manufacture of spiegeleisen have been opened and their product is now being utilized.

We subjoin several representative analyses of Alabama ores which we receive from an entirely trustworthy source.

	Magnetic.	Red Hematite.		
		1.	2.	3.
Oxide of iron.....	66.05	63.87	84.58	80.64
Oxide of manganese.....	10.25	.23	.40	.40
Alumina.....	6.98	.29	3.14	.50
Lime.....		.18	5.06	.12
Magnesia.....		.43	1.23	.33
Silica.....	13.00	33.22	5.54	16.80
Phosphoric acid.....	1.08	1.16	.07	.88
	97.36	99.38	100.02	99.67
Metallic iron.....	47.83	44.71	61.240	56.45
Phosphorus.....	.147	.50	.030	.34

The iron ores of Tennessee have long been celebrated. Bar iron was made in its Catalan forges a hundred years ago, and fifty years ago iron was made in considerable quantities in this State and shipped to Pittsburgh in the form of blooms. Much of the capital that was then used in developing its iron-making resources was supplied by Pennsylvania ironmasters. In the manufacture of car-wheels and best refined bar iron the iron ores of Tennessee have no superior. As one result of the extension of the railroad system of the State it is supposed that larger deposits of iron ore than have ever been worked within its borders will soon be developed. The iron ores of this State exist in such great variety that any analyses we might give of them in our limited space would represent only a small part of them.

The most important iron-making district in Kentucky is the Hanging Rock district, and yet this district now draws its principal supply of ore from Bath county in the same State, but outside of the district. Considerable quantities of ore from Bath county are annually sent to Ashland, Kentucky, and also to Ironton and Columbus, Ohio. An average analysis of the ores of Bath county is as follows:

Peroxide of iron.....	76.070	Water.....	12.310
Alumina.....	2.590		100.561
Lime.....	.130		
Magnesia.....	.281	Metallic iron.....	48.00
Silica.....	8.180	Manganese.....	.48
Phosphoric acid.....	1.000	Phosphorus.....	.70

The only reason why the Hanging Rock region draws a

large part of its supply of ore from Bath county appears to be the greater richness of this ore as compared with Hanging Rock ores. The latter average about 32 per cent. of metallic iron, whereas the Bath county ore averages, as has just been shown, about 48 per cent. The requirements of modern furnace practice and the severity of competition now militate greatly in all sections against the use of lean ores. The Bath county ores produce a soft, fluid iron, very suitable for foundry purposes. The first blast furnace in Kentucky was built in Bath county in 1791. The iron ores of other sections of Kentucky produce excellent iron for rolling-mill purposes.

20. Outside of Missouri none of the States and Territories lying west of the Mississippi river have developed an iron industry of especially significant proportions. Colorado and California have made the most progress in this direction, but even their achievements have fallen very far short of the results accomplished by many of the older States. Nearly all of the States and Territories west of the Mississippi contain iron ore, but this part of our country is too vast and too new, and transportation within its limits is too restricted, to have either called for or permitted much attention to the manufacture of iron. In the light of present developments we may safely conclude that the iron industry west of the Mississippi and outside of Missouri will be of very slow growth. The most recent and valuable discovery of iron ore in the section of country under consideration has been made in Arkansas, where ore of a character suitable for the manufacture of spiegeleisen has been found in Independence county in large quantities, and is now being used by Carnegie Brothers & Company Limited and the Cambria Iron Company.

Summary.—The foregoing bird's-eye view of the iron-ore resources of our country establishes a number of important facts. It brings freshly to mind the remoteness from points of ultimate consumption of the great Lake Superior iron-ore fields, where quantity and quality of ore are found in combinations unequalled in any other section. It shows that, widely as iron ores are distributed in this country, such of these ores as are suitable for the manufacture of steel are confined to comparatively limited areas, but that they are in abundant supply. It shows that some of the most important iron-ore deposits in the

country have been developed since the boom of 1879 and 1880. It shows that foreign ores, obtained in Spain, Italy, and other countries, are yearly imported into many States to be used either alone or as a mixture with native ores, and that the reasons for this importation are, first, their excellence for special purposes, particularly the manufacture of Bessemer pig iron and spiegeleisen, and, second, their cheapness as compared with native ores that must be transported long distances by rail. We do not, however, import annually one-fifth as much foreign ore as Great Britain, nor one-half as much as France or Belgium, and but little more than one-half as much as Germany. As has been shown, our imports of iron ore in 1884 amounted to only one-sixteenth of the total quantity of domestic iron ore consumed in that year.

If the question were asked whether this country could, if required, supply from within its own borders all of the iron ore needed in every branch of its iron and steel industries, including the manufacture of the finer kinds of crucible steel, the answer might unhesitatingly be made in the affirmative. We can make as good iron for crucible steel as the Swedes do if we would only be as painstaking as they are. We have ores in great abundance for the manufacture of Bessemer steel by the original, or acid, process, which is the only process for the manufacture of this kind of steel that now exists in this country, if we except one unsatisfactory experiment that has recently been made with the Thomas-Gilchrist, or basic, process, and one establishment for the manufacture of steel by the Clapp-Griffiths process. These ores are, however, not readily accessible to all the Bessemer establishments of the country. We have discovered ores for the manufacture of spiegeleisen and ferro-manganese that would place our steel industry on a self-sustaining basis if our foreign supply of these products should be interrupted. We would be better off in this particular than Great Britain, which is practically without manganese iron-ore deposits. Manganese itself we export to that country. The firm of Carnegie Brothers & Company Limited, of Pittsburgh, uses only domestic ore in the manufacture of its high-grade ferro-manganese.

As steel has rapidly come into use in late years as a substitute for iron, not only for rails but for other purposes, it is

a fact of some interest, to which, we believe, public attention has not heretofore been called, that pig iron suitable for the manufacture of Bessemer steel by the process that is now in use in this country has never been made in any part of the country south of the Potomac or south of Wheeling. Southern ores, with rare exceptions, are too high in phosphorus for the purpose mentioned. If the South should engage in the manufacture of Bessemer steel to a greater extent than it has yet done at Wheeling it would probably employ the Thomas-Gilchrist process, which requires that pig iron should be high in phosphorus that the work of elimination in the converter may be completely successful; or it would employ the Clapp-Griffiths process, which is said to permit the presence in the steel itself of a large percentage of phosphorus without detriment to its quality, a result which is only rendered possible by the rigorous exclusion of silicon.

May, 1885.

JAMES M. SWANK.



